Amongst the data collected will be, not only the actual distribution of the plants, but also the time of flowering and other information such as habit, etc. Moreover, collectors will be asked to secure whenever possible seeds as well, and these Mr. Bailey has undertaken to grow for us, so that eventually in the Botanic Gardens we may see plots of our native flowering plants—and many are most beautiful—labelled as being the result of the activities of the Field Naturalists' Section of the Royal Society. Here we have an opportunity for doing useful work, valuable work, really important work. With many hands and division of labour it is work of relatively easy accomplishment. It is work that will bring real credit to the section. It is work that **no one and no body in Australia has as yet attempted to do on a large scale.** Let us get to work forthwith and each one do his share to make the undertaking a success.

THE BREEDING HABITS OF THE "BACK-SWIMMER" (Anisops hyperion).

(Herbert M. Hale, South Australian Museum).

In a previous article published in Vol. ii. p. 54 of the "Naturalist," mention was made of the family of aquatic bugs popularly known as "back-swimmers." The members of this group are all of comparatively small size, and our largest representative is about half an inch in length. Much has been written of the biology of some of the species, those of Notonecta, the type genus, having in particular received considerable attention. Nevertheless, until comparatively recently, it was thought that all of the Neotropical Notonectae attached their eggs to the surface of plants with a pad of adhesive material, but a worker on the group has proved that at least three of the twelve American species have a long ovipositor and insert their eggs in plant tissues.

A revision of the Australian representatives of the family together with a fuller account of the biology of Anisops hyperion, will be found in Vol. ii. of the "Records of the South Australian Museum." The examination of a large amount of material showed that Notonecta is poorly represented in Australia; indeed, only one of our species can be definitely assigned to that genus, the majority of them belonging to Anisops; the lastnamed genus, although widely distributed, has been neglected biologically, the life history of none of its species having been previously recorded.

No migrations of back-swimmers have been recorded in Australia, but migrations en masse must occur, for myriads of adults sometimes appear in dams, etc., which a day or two before were destitute of bug life. In 1847 the migration of a tremendous host of an American species was observed by Sir George Simpson. The recorder of the occurrence says that the bugs were suddenly incapacitated through encountering

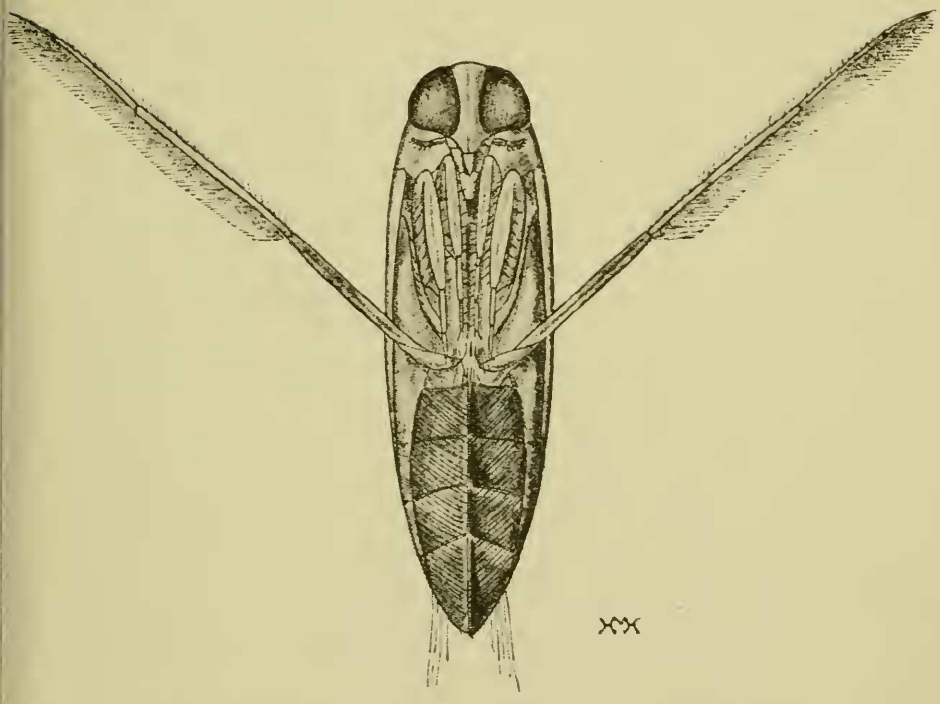

Fig. 1.—Anisops hyperion, ventral view. Poising position as seen from above when in the water.

two chitinous members, each with a saw-like edge of strong teeth, and it is with these gouging gonapophyses that a receptacle for the egg is prepared. An examination of the ovipositor of other Australian members of the genus shows that it is quite safe to assume that all of our species have the same habit.

No migrations of back-swimmers have been recorded in Australia, but migrations en masse must occur, for myriads of adults sometimes appear in dams, etc., which a day or two before were destitute of bug life. In 1847 the migration of a tremendous host of an American species was observed by Sir George Simpson. The recorder of the occurrence says that the bugs were suddenly incapacitated through encountering a freezing stratum of air, and fell to the ground in countless numbers, covering a space 25 to 30 miles in length and of a width unable to be determined!

The back-swimmer now dealt with is one of our commonest aquatic bugs, and in the breeding season sometimes occurs in such very great numbers that hundreds may be captured with a single sweep of the net. Although somewhat shy, it is easily maintained in aquaria; it readily feeds upon mosquito larvae and must therefore be considered of some economic importance. A preliminary examination of the insect itself will repay our interest. The first adaptation which may be noted is that of the underside of the abdomen; as is usual with the majority of the back-swimmers, this has a median keel or carina, on each side of which is a trough. Guard hairs close over these troughs which thus form reservoirs for the storing of air which is utilised during submergence. The legs are also modified for an aquatic habit; the posterior pair are very long, flattened, and fringed with long hairs, and operate as paddles or oars; the anterior and middle legs are shorter, concave on the inner surfaces and with the edges set with long bristles which serve for the retention of living prey. In the male the anterior tibiae are further specialised, the base on the inner side being expanded to form a spur on which is situated a stridulatory comb; this comb operates against chitinous prongs, which project one on each side of the beak, the friction of the two members under water producing a shrill prolonged note. The female lacks this stridulatory apparatus and differs from the male in several other minor characters. It is now proved that the species under discussion inserts its eggs into plants; if the ovipositor of the female is dissected out on a microscope slide, it will be seen that one of the pairs of forceps or "gonapophyses" of which it is composed, consists of two chitinous members, each with a saw-like edge of strong teeth, and it is with these gouging gonapophyses that a receptacle for the egg is prepared. An examination of the ovipositor of other Australian members of the genus shows that it is quite safe to assume that all of our species have the same habit.

The species of Anisops have an almost perfect poise in the water when the respiratory troughs are charged with air and, excepting for the deposition of eggs, rarely cling to plant stems as do the larger Enithares and Notonectae. In poising the posterior legs project outwards and a little forwards; every few seconds they are utilised to correct the slight tendency to automatically ascend or sink. Excepting during copulation, egg-depostion or feeding the anterior limbs are folded while the insects are submerged. (Fig. 1).

For the purpose of learning the life history of Anisops hyperion specimens were maintained in aquaria for eight months, at the end of which time they were quite accustomed to their somewhat unusual surroundings and mated. At the approach of summer, that is about the month of September, the males begin the courtship of the females, a most fascinating procedure. A male swims below and a little behind a female, and, stridulating all the time, accompanies her every movement until she responds to his blandishments. The stridulation is loud, and is quite easily discerned across the width of a room: it may be likened to the sound of a distant grindstone at work, and is often continued intermittently for the whole of a day. The female lays only a few eggs a day, the period for oviposition occupying about a month. As mentioned above, the eggs are inserted into plant stems and leaves, a method of concealment which doubtless serves as a protection against predators. Wherever possible the bug selects a moderately thick-stemmed plant. When "Water Milfoil" (Myriophyllum) and "Pondweed" (Potamogeton) are present in localities where Anisops is breeding, the stems of these plants will be found to contain ova. In the aquaria the bugs were supplied with plants of Potamogeton tricarinatus, a local water-weed, and these served admirably as nidi. In ovipositing the female grasps the stem with the intermediate and anterior legs, the posterior legs remaining extended as in the swimming or poising position. The surface of the plant is explored with the end of the abdomen, the bug walking along the stem until a suitable site is selected. The ovipositor is then extruded and the drilling gonapophyses work at the stem with a circular, scraping motion until a hole of sufficient size to accommodate an egg is completed. The egg is then inserted into the prepared cavity, leaving a small portion of the egg-shell exposed at the mouth. Finally, the sensitive lip of the pygidium moves over this exposed surface and the surrounding edges of the cavity

as if to make sure that the operation has been successful. The female then swims away, vigorously cleaning the ovipositor from particles of plant tissue with the hind legs; the whole operation of boring the hole and depositing the ovum occupies about one minute. While egg-laying is in progress the males seem greatly excited, stridulating continually, and following the females around the aquarium.

At least two generations occur every summer; the period of incubation for the eggs varies according to the temperature of the water and the time of the year. Those we are discussing were laid in early spring, and take about three weeks to hatch. A fortnight after deposition the first external indication of the enclosed embryo is apparent, two smudges of red pigment appearing near the apex of the egg; these bodies are the developing eyes of the little bug as seen through the semi-transparent chitin of the egg-shell. The patches become more prominent, and in a few days, when the nymph is almost ready to hatch, they have assumed a kidney-like shape and are dark red in color. In hatching, the nymph bursts open the top end of the egg-shell and struggles out head first; the little fellow resembles in general the adult, but is, of course, very tiny, being less than 2 mm. in total length. The most striking differences are that all the tarsi are one-jointed with much longer claws than in the imago, the venter lacks the abdominal gutters, the eyes are small and widely separated, and there are no traces of wings. As the nymph hatches below the surface, the guard hairs immediately after emergence contain no trapped air, but are quite limp; the nymph is therefore not buoyant, and makes many spasmodic and unsuccessful attempts to reach the surface film and so gain access to the air. Several examples in this condition were isolated in a small vessel, and for three days tumbled about awkwardly, often sinking to the bottom dorsum uppermost—which is "wrong side up" for a back-swimmer when it is in the water; During this period "dissolved" air may have been absorbed through the skin by osmotic action, for the abdominal hairs held no air whatever. Once, however, that the nymph has succeeded in introducing air beneath the guard hairs, it is in immediate control of its movements, poising in the water as do the adults, and at once commencing to feed. As a means of providing food for the youngsters egg-rafts of the Common Grey Mosquito (Culex fatigans) were placed on the surface of the water; the little bugs easily mastered the tiny mosquito larvae as they emerged. The nymphs are quite as rapacious as the adults, and as successive stages are attained larger

aquatic animals are captured by them. On account of their predatory habit, it was found necessary to isolate each individual in a separate jar, for otherwise the smallest examples were destroyed by their larger brethren.

As is well-known, bugs have an "incomplete" metamorphosis; the nymph of our back-swimmer moults its skin five times before it finally attains maturity, an increase in size and some developmental changes being apparent after each ecdysis. The transition, unlike that of insects which undergo a "complete" metamorphosis, is gradual. It may be said that when, for instance, the bug attains the second stage or instar, the third instar nymph begins to form inside the skin of the second instar nymph; then, when the stage is completed, the skin is split along the back and the nymph emerges, immediately expands to the proportions of the third instar, and so on until the fifth and final moult. The ventral carina and respiratory gutters are present in the second instar, and the first indications of wing-pads appear in the next, or third stage. The last nymphal stage is reached about a month after hatching, and as these fifth instar nymphs near the final moult, the characters of the developing adult may be seen through the semi-transparent integument by means of strong transmitted light under the microscope. The stridulatory apparatus of the male is thus visible, and other structures of both sexes may be similarly discerned, so that it is possible to determine with ease the sex of advanced individuals of this instar. When the metamorphosis is completed, the integument of the adult is at first soft, and little color is apparent on the underside of the abdomen.

In aquaria each nymph captured on an average 200 mosquito larvae between the second and last moults, and a laying female consumed 70 large larvae and pupae in one month. Food is held with the bristle-edged anterior and intermediate legs, the victim being dexterously turned about as the beak is applied to fresh portions.

As an experiment a laying female was isolated in a vessel containing plants of Italian Ribbon-weed (Vallisneria spiralis), but no other vegetation. The thin, tape-like leaves of this water-plant are not suited for the reception of eggs, and in a week or so many unoccupied perforations indicated abortive attempts to prepare cavities in which to conceal the ova. Eggs were, however, pushed into certain of the slits cut in the leaves, but were, of course, largely exposed.